

WHAT IS CLAIMED IS:

1. A process for making a panel-like structure mountable in an automobile vehicle to form a part of the interior thereof, the panel-like structure including an outer layer defining an exterior surface of the structure, at least a portion of which is exposed to the vehicle interior, and a rigid substrate which is hidden from the vehicle interior when the panel-like structure is mounted in the automobile vehicle, said process comprising the steps of:

applying a water-dispersed composition comprising at least one light-stable aliphatic thermoplastic polyurethane containing at least one pendent functional group selected from the group consisting of hydroxyl and carboxyl functional groups, at least one desired coloring agent, and at least one heat-activated reactive crosslinking agent onto a first mold surface having a shape complementary to the outer layer;

heating and crosslinking the light-stable aliphatic thermoplastic polyurethane with the heat-activated reactive crosslinking agent;

substantially drying the water-dispersed composition while on the first mold surface to form the outer layer with an exterior surface, at least a portion of which has the desired touch, color, and configuration of the panel-like structure;

casting a composition comprising poly(vinyl chloride) containing at least one plasticizer onto an inner surface of the outer layer while on the first mold surface to form an inner layer having the plasticizer crosslinked with the polyurethane of the outer layer via unreacted functional groups of the heat-activated reactive crosslinking agent and interfacially chemically bond the inner surface of the outer layer to an adjacent surface of the inner layer; and

uniting the inner layer with the outer layer interfacially chemically bonded thereto with the rigid substrate so that the rigid substrate reinforces the outer layer while retaining the touch and color of the exposed portion.

2. A process according to claim 1, wherein the heat-activated reactive crosslinking agent is carbodiimide.

3. A process according to claim 2, wherein the plasticizer contains one or more pendent hydroxyl, carboxyl, or hydroxyl and carboxyl functional groups.

4. A process according to claim 3, further comprising the steps of:

transferring the inner layer with the outer layer interfacially chemically bonded thereto from the first mold surface to a second mold surface; and

providing the rigid substrate on a third mold surface having a complementary shape to an interior surface of the panel-like structure,

wherein said uniting step comprises applying a reactive mixture to the inner layer with the outer layer interfacially chemically bonded thereto while on the second mold surface or to the rigid substrate provided on the third mold surface, arranging the second and third mold surfaces so that the inner layer with the outer layer interfacially chemically bonded thereto and the rigid substrate collectively define a mold cavity for accommodating the reactive mixture, and foaming

the reactive mixture to form a relatively rigid polyurethane cellular foam that adheres the rigid substrate to the inner layer with the outer layer interfacially chemically bonded thereto, and wherein the outer layer is provided with a compressing feel by the relatively rigid polyurethane foam and the inner layer.

- 5 5. A process according to claim 3, further comprising the steps of:
transferring the inner layer with the outer layer interfacially chemically bonded thereto from the first mold surface to a transparent surface of a holding platform;
detecting and reinforcing rupturable portions of the inner layer with the outer layer interfacially chemically bonded thereto to prevent failure of the same during said uniting step;
10 transferring the inner layer with the outer layer interfacially chemically bonded thereto from the transparent surface to a second mold surface; and
providing the rigid substrate on a third mold surface having a complementary shape to an interior surface of the panel-like structure,
wherein said uniting step comprises applying a reactive mixture to the inner layer with
15 the outer layer interfacially chemically bonded thereto while on the second mold surface or to the rigid substrate provided on the third mold surface, arranging the second and third mold surfaces so that the inner layer with the outer layer interfacially chemically bonded thereto and the rigid substrate collectively define a mold cavity for accommodating the reactive mixture, and foaming the reactive mixture to form a relatively rigid polyurethane cellular foam that adheres the rigid
20 substrate to the inner layer with the outer layer interfacially chemically bonded thereto, and
wherein the outer layer is provided with a compressing feel by the relatively rigid polyurethane foam and the inner layer.
6. A process according to claim 3, wherein said drying step is performed by evaporating the water from the water-dispersed composition.
- 25 7. A process according to claim 3, wherein the outer layer has a thickness in a range of from about 1.0 mils to about 1.5 mils.
8. A process according to claim 3, wherein the inner layer has a thickness in a range of from about 40 mils to about 60 mils.
9. A process according to claim 3, further comprising the step of precoating the first mold
30 surface with a microcrystalline wax mold releasing agent.
10. A process according to claim 3, wherein the light-stable aliphatic thermoplastic polyurethane and the heat-activated reactive crosslinking agent can be premixed and stably stored prior to said applying step for at least up to 24 hours at room temperature.
11. A process according to claim 3, wherein the first mold surface is heated during said
35 applying step.
12. A process according to claim 3, wherein the first mold surface has a complementary shape to an exterior surface of a door panel.
13. A process according to claim 3, wherein the first mold surface has a complementary

shape to an exterior surface of an instrument panel.

14. A process according to claim 3, wherein said casting composition comprises a low molecular weight plasticizer and a medium molecular weight plasticizer.

15. A process according to claim 3, wherein said poly(vinyl chloride) of said casting composition comprises a copolymer blend or alloy.

16. A process for making a panel-like structure mountable in an automobile vehicle to form a part of the interior thereof, the panel-like structure including an outer layer defining an exterior surface of the structure, at least a portion of which is exposed to the vehicle interior, and a rigid substrate which is hidden from the vehicle interior when the panel-like structure is mounted in the automobile vehicle, said process comprising the steps of:

precoating a microcrystalline wax mold releasing agent on a first mold surface, the first mold surface being heated to a first elevated temperature to melt and disperse the microcrystalline wax mold releasing agent;

applying a water-dispersed composition comprising at least one light-stable aliphatic thermoplastic polyurethane containing at least one pendent functional group selected from the group consisting of hydroxyl and carboxyl functional groups, at least one desired coloring agent, and at least one heat-activated reactive crosslinking agent onto the first mold surface containing the microcrystalline wax mold releasing agent dispersed thereon, the first mold surface having a complementary shape to the outer layer and being heated to a second elevated temperature;

substantially drying the water-dispersed composition while on the first mold surface by heating the first mold surface to a third elevated temperature to form the outer layer with an exterior surface, at least a portion of which has the desired touch, color, and configuration of the panel-like structure;

casting a composition comprising a poly(vinyl chloride) containing at least one plasticizer onto an inner surface of the outer layer while on the first mold surface to form an inner layer having the plasticizer crosslinked with the polyurethane of the outer layer via unreacted functional groups of the heat-activated reactive crosslinking agent and interfacially chemically bond the inner surface of the outer layer to an adjacent surface of the inner layer; and

uniting the inner layer with the outer layer interfacially chemically bonded thereto with the rigid substrate so that the rigid substrate reinforces the outer layer while retaining the touch and color of the exposed portion.

17. A process according to claim 16, wherein the heat-activated reactive crosslinking agent is carbodiimide.

18. A process according to claim 16, wherein the plasticizer contains one or more pendent hydroxyl, carboxyl, or hydroxyl and carboxyl functional groups.

19. A process according to claim 18, wherein the first elevated temperature, second elevated temperature, and third elevated temperature are all the same and in a range of from about 140EF to about 160EF.

20. An article comprising a panel-like structure mountable in an automobile vehicle to form a part of the interior thereof, the panel-like structure having an exterior surface, at least a portion of which is exposed to the vehicle interior, and an interior surface which is hidden from the vehicle interior when the panel-like structure is mounted in the automobile vehicle, said panel-like structure comprising:

a rigid substrate;

a layered composite structure comprising an outer layer defining at least a portion of said exterior surface of the panel-like structure and an inner layer, said layered composite structure being united to a surface of said rigid substrate so that said rigid substrate serves to reinforce said outer layer while retaining the touch and color of the exposed portion;

said outer layer having the desired touch, color, and configuration of the panel-like structure and comprising an at least substantially dried, light-stable, crosslinked polyurethane formulated from a water-dispersed composition comprising at least one desired coloring agent, at least one light-stable aliphatic thermoplastic polyurethane containing at least one pendent functional group selected from the group consisting of hydroxyl and carboxyl functional groups, and at least one heat-activated reactive crosslinking agent, said light-stable aliphatic thermoplastic polyurethane being molded with and crosslinked by the heat-activated reactive crosslinking agent on a mold surface having a shape complementary to a configuration of said outer layer and said light-stable aliphatic thermoplastic polyurethane also being dried on the mold surface; and

said inner layer being thicker than said outer layer and comprising poly(vinyl chloride), said poly(vinyl chloride) being formed directly on said outer layer such that said inner layer has a surface adjacent to and interfacially chemically bonded with an inner surface of said outer layer, said inner layer and said interfacial chemical bonds being formed by casting a composition comprising poly(vinyl chloride) containing at least one plasticizer onto said inner surface of said outer layer while on said mold surface.

21. An article according to claim 20, wherein the heat-activated reactive crosslinking agent is carbodiimide.

22. An article according to claim 20, wherein the plasticizer contains one or more pendent hydroxyl, carboxyl, or hydroxyl and carboxyl functional groups.

23. An article according to claim 22, further comprising a relatively rigid polyurethane cellular foam interposed between said layered composite structure and said rigid substrate that adheres said layered composite structure to said rigid substrate, wherein said outer layer is provided with a compressing feel by said relatively rigid polyurethane cellular foam and said inner layer.

24. An article according to claim 23, wherein said outer layer has a thickness in a range of from about 1.0 mils to about 1.5 mils.

25. An article according to claim 23, wherein said inner layer has a thickness in a range of

from about 40 mils to about 60 mils.

26. An article according to claim 23, wherein said light-stable aliphatic thermoplastic polyurethane and said heat-activated reactive crosslinking agent can be premixed and stably stored for at least up to 24 hours at room temperature.

27. An article according to claim 23, wherein said casting composition comprises a low molecular weight plasticizer and a medium molecular weight plasticizer.

28. An article according to claim 23, wherein said poly(vinyl chloride) comprises a copolymer blend or alloy.

29. An article according to claim 23, wherein said panel-like structure is a door panel.

30. An article according to claim 23, wherein said panel-like structure is an instrument panel.

31. A process for making a panel-like structure mountable in an automobile vehicle to form a part of the interior thereof, the panel-like structure including an outer layer defining an exterior surface of the structure, at least a portion of which is exposed to the vehicle interior, and a rigid substrate which is hidden from the vehicle interior when the panel-like structure is mounted in the automobile vehicle, said process comprising the steps of:

applying a water-dispersed composition comprising at least one light-stable aliphatic thermoplastic polyurethane containing at least one pendent functional group selected from the group consisting of hydroxyl and carboxyl functional groups, at least one desired coloring agent, and at least one heat-activated reactive crosslinking agent onto a first mold surface having a shape complementary to the outer layer;

heating and crosslinking the light-stable aliphatic thermoplastic polyurethane with the heat-activated reactive crosslinking agent;

substantially drying the water-dispersed composition while on the first mold surface to form the outer layer with an exterior surface, at least a portion of which has the desired touch, color, and configuration of the panel-like structure;

casting a composition comprising a thermoplastic polyurethane resin material having at least one ethylenically unsaturated bond in its backbone, at least one pendent hydroxyl group, or a combination thereof onto an inner surface of the outer layer while on the first mold surface to form an inner layer which comprises the thermoplastic polyurethane resin material crosslinked with the light-stable aliphatic polyurethane of the outer layer via unreacted functional groups of the heat-activated reactive crosslinking agent and interfacially chemically bond the inner surface of the outer layer to an adjacent surface of the inner layer; and

uniting the inner layer with the outer layer interfacially chemically bonded thereto with the rigid substrate so that the rigid substrate reinforces the outer layer while retaining the touch and color of the exposed portion.

32. A process according to claim 31, wherein the heat-activated reactive crosslinking agent is carbodiimide.

33. A process according to claim 32, further comprising the steps of:

transferring the inner layer with the outer layer interfacially chemically bonded thereto from the first mold surface to a second mold surface; and

providing the rigid substrate on a third mold surface having a complementary surface to an interior surface of the panel-like structure,

5 wherein said uniting step comprises applying a reactive mixture to the inner layer with the outer layer interfacially chemically bonded thereto while on the second mold surface or to the rigid substrate provided on the third mold surface, arranging the second and third mold surfaces so that the inner layer with the outer layer interfacially chemically bonded thereto and the rigid substrate collectively define a mold cavity for accommodating the reactive mixture, and foaming
10 the reactive mixture to form a relatively rigid polyurethane cellular foam that adheres the rigid substrate to the inner layer with the outer layer interfacially chemically bonded thereto, and
 wherein the outer layer is provided with a compressing feel by the relatively rigid polyurethane foam and the inner layer.

34. A process according to claim 32, further comprising the steps of:

15 transferring the inner layer with the outer layer interfacially chemically bonded thereto from the first mold surface to a transparent surface of a holding platform;

 detecting and reinforcing rupturable portions of the inner layer with the outer layer interfacially chemically bonded thereto to prevent failure of the same during said uniting step;

 transferring the inner layer with the outer layer interfacially chemically bonded thereto
20 from the transparent surface to a second mold surface; and

 providing the rigid substrate on a third mold surface having a complementary shape to an interior surface of the panel-like structure,

 wherein said uniting step comprises applying a reactive mixture to the inner layer with the outer layer interfacially chemically bonded thereto while on the second mold surface or to the
25 rigid substrate provided on the third mold surface, arranging the second and third mold surfaces so that the inner layer with the outer layer interfacially chemically bonded thereto and the rigid substrate collectively define a mold cavity for accommodating the reactive mixture, foaming the reactive mixture to form a relatively rigid polyurethane cellular foam that adheres the rigid
 substrate to the inner layer with the outer layer interfacially chemically bonded thereto, and

30 wherein the outer layer is provided with a compressing feel by the relatively rigid polyurethane foam and the inner layer.

35. A process according to claim 32, wherein said drying step is performed by evaporating the water from the water-dispersed composition.

36. A process according to claim 32, wherein the outer layer has a thickness in a range of
35 from about 1.0 mils to about 1.5 mils.

37. A process according to claim 32, wherein the inner layer has a thickness in the range of from about 40 mils to about 60 mils.

38. A process according to claim 32, further comprising the step of precoating the first mold

surface with a microcrystalline wax mold releasing agent.

39. A process according to claim 32, wherein the light-stable aliphatic thermoplastic polyurethane and the heat-activated reactive crosslinking agent can be premixed and stably stored prior to said applying step for at least up to 24 hours at room temperature.

5 40. A process according to claim 32, wherein the first mold surface is heated during said applying step.

41. A process according to claim 32, wherein the first mold surface has a complementary shape to an exterior surface of a door panel.

10 42. A process according to claim 32, wherein the first mold surface has a complementary shape to an exterior surface of an instrument panel.

43. A process for making a panel-like structure mountable in an automobile vehicle to form a part of the interior thereof, the panel-like structure including an outer layer defining an exterior surface of the structure, at least a portion of which is exposed to the vehicle interior, and a rigid substrate which is hidden from the vehicle interior when the panel-like structure is mounted in
15 the automobile vehicle, said process comprising the steps of:

providing a microcrystalline wax mold releasing agent on a first mold surface, the first mold surface being heated to a first elevated temperature to melt and disperse the microcrystalline wax mold releasing agent;

20 applying a water-dispersed composition comprising at least one light-stable aliphatic thermoplastic polyurethane containing at least one pendent functional group selected from the group consisting of hydroxyl and carboxyl functional groups, at least one desired coloring agent, and at least one heat-activated reactive crosslinking agent onto the first mold surface containing the microcrystalline wax mold releasing agent dispersed thereon, the first mold surface having a complementary shape to the outer layer and being heated to a second elevated temperature;

25 substantially drying the water-dispersed first composition while on the first mold surface by heating the first mold surface to a third elevated temperature to form the outer layer with an exterior surface, at least a portion of which has the desired touch, color, and configuration of the panel-like structure;

30 casting a second composition comprising a thermoplastic polyurethane resin material having at least one ethylenically unsaturated bond in its backbone, at least one pendent hydroxyl group, or a combination thereof onto an inner surface of the outer layer while on the first mold surface to form an inner layer which comprises the polyurethane crosslinked with the light-stable aliphatic thermoplastic polyurethane of the outer layer via unreacted functional groups of the heat-activated reactive crosslinking agent and interfacially chemically bond the inner surface of
35 the outer layer to an adjacent surface of the inner layer; and

uniting the inner layer with the outer layer interfacially chemically bonded thereto with the rigid substrate so that the rigid substrate reinforces the outer layer while retaining the touch and color of the exposed portion.

44. A process according to claim 43, wherein the heat-activated reactive crosslinking agent is carbodiimide.

45. A process according to claim 44, wherein the first elevated temperature, second elevated temperature, and third elevated temperature are all the same and in a range of from about 140EF to about 160EF.

46. An article comprising a panel-like structure mountable in an automobile vehicle to form a part of the interior thereof, the panel-like structure having an exterior surface, at least a portion of which is exposed to the vehicle interior, and an interior surface which is hidden from the vehicle interior when the panel-like structure is mounted in the automobile vehicle, said panel-like

structure comprising:

a rigid substrate;

a layered composite structure comprising an outer layer defining at least a portion of said exterior surface of the panel-like structure and an inner layer, said layered composite structure being united to a surface of said rigid substrate so that said rigid substrate serves to reinforce said outer layer while retaining the touch and color of the exposed portion;

said outer layer having the desired touch, color, and configuration of the panel-like structure and comprising an at least substantially dried, light-stable, crosslinked polyurethane formulated from a water-dispersed first composition comprising at least one desired coloring agent, at least one light-stable aliphatic thermoplastic polyurethane containing at least one pendent functional group selected from the group consisting of hydroxyl and carboxyl functional groups, and at least one heat-activated reactive crosslinking agent, said light-stable aliphatic thermoplastic polyurethane being molded with and crosslinked by the heat-activated reactive crosslinking agent on a mold surface having a shape complementary to a configuration of said outer layer and said light-stable aliphatic thermoplastic polyurethane also being dried on the mold surface; and

said inner layer being thicker than said outer layer and being formed directly on said outer layer such that said inner layer has a surface adjacent to and interfacially chemically bonded with an inner surface of said outer layer, said inner layer and said interfacial chemical bonds being formed by casting a composition comprising a thermoplastic polyurethane resin material having at least one ethylenically unsaturated bond in its backbone, at least one pendent hydroxyl group, or a combination thereof onto said inner surface of said outer layer while on said mold surface.

47. An article according to claim 46, wherein the heat-activated reactive crosslinking agent is carbodiimide.

48. An article according to claim 47, further comprising a relatively rigid polyurethane cellular foam interposed between said layered composite structure and said rigid substrate that adheres said layered composite structure to said rigid substrate, wherein said outer layer is provided with a compressing feel by said relatively rigid polyurethane cellular foam and said

inner layer.

49. An article according to claim 48, wherein said outer layer has a thickness in a range of from about 1.0 mils to about 1.5 mils.

50. An article according to claim 48, wherein said inner layer has a thickness in a range of
5 from about 40 mils to about 60 mils.

51. An article according to claim 48, wherein said at least one light-stable aliphatic thermoplastic polyurethane and said heat-activated reactive crosslinking agent can be premixed and stably stored for at least up to 24 hours at room temperature.

52. An article according to claim 48, wherein said panel-like structure is a door panel.

10 53. An article according to claim 48, wherein said panel-like structure is an instrument panel.